

## **Smart Toilet– An IoT Solution**

**Sandeep Sangwan<sup>1</sup>, Nikhil Chugh<sup>2</sup>, Pradyumn Kumar Tiwari<sup>3</sup>**

### **ABSTRACT**

*Aim of this paper is to analyze the benefits and need of regular health checkups tests and present an IoT solution architecture. Now a day's people rarely get time to go for general health checkups. Everything is going smart however, we are still using conventional toilets. Medical conditions like kidney stone, pregnancy, etc. can very easily be detected by testing on human body waste. So, why can't we have a smart toilet which will perform these very basic tests? We propose an IoT based smart toilet system which can easily test user body waste and help him to track and share reports to doctor to guide the user on how to improve his health. To maintain the privacy, user's profile & sessions are maintained.*

### **I. INTRODUCTION**

There have been many cases identified in which patients get to know about the disease in the later stages. Their conditions could be avoided if the tests were performed in earlier stages of the diseases. Doctors always insist on getting regular checkups done to diagnose the disease at the earlier stages so as to avoid serious implications.

There are apps now which help you virtually meet your doctor and doctor can also take all your tests done on the same platform. So, this avoids the regular visits to the doctors that patients had to do earlier. However, some diseases or conditions that are very common are ignored by the people or are delayed in diagnosis. So, there arises the need for a solution that helps people to diagnose these common diseases without interfering with the daily chores of people. Because people rarely go for regular checkups like these and hence this prevents the early diagnose of the disease or the medical condition. In order to solve this problem, we propose a smart toilet system. This system can be used to track and to guide the user on how to improve his health. This smart toilet, apart from providing a cleaner option to discard human body waste, also helps in performing some tests on the body wastes and can even share the reports to the doctors on user's consent. The smart toilet uses tests performed on urine and stool to diagnose very basic and common medical conditions like pregnancy, kidney stones, constipation, etc. Also, to protect the privacy of the user smart toilet has user profiles. A user can login using his password or directly using the biometrics when entering the toilet.

According to the data shared by Nana Palkar Smruti Samiti, there has been continuous increase in the no. of tests performed on patients in last 10 years:

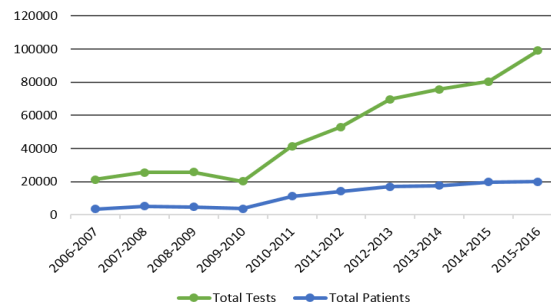


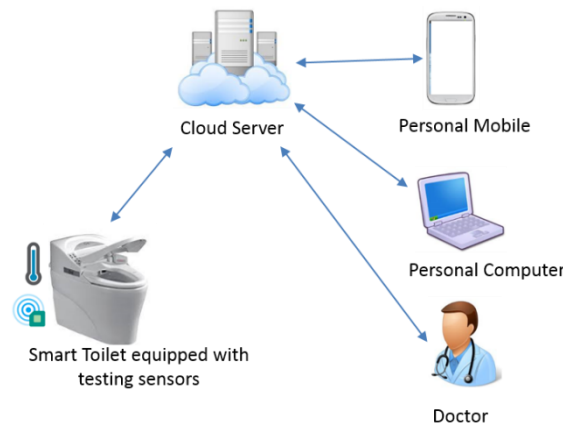
Figure 1. statistics of tests conducted during last 10 years in lab.

Considering the health concerns, Govt. of India has also taken initiative in the Union Budget of 2016-17 to provide insurance coverage to the economically weaker sections. Govt. of India is also running schemes that help in development of toilets in rural areas.

According to the data shared by Dr. Lal Path Labs, one of India’s leading pathology laboratory chains, the size of the diagnostics industry was around Rs. 377 billion in 2014-2015 and will continue to grow by a CAGR of 16%-17% over the next two years, to cross Rs 600 billion by 2017-2018. Dr. Lal Path Labs, on yearly basis, adds 15-25 satellite labs to their network.

### 1.Smart Toilet

We hereby present a plausible solution which is capable of maintaining user profiles and generalhealth



parameters of the users.

Figure 2.smart toilet solution using IoT

The user enters the toilet and automatically logs-in by the inbuilt fingerprint sensor on the door handle when he opens the door. Now, as the toilet recognizes its user, it makes all the necessary changes like the ambient lighting, music, seat temperature, water temperature, etc. for that particular user. A weighing machine is placed near the toilet seat which calculates the weight of the user. As toilet already knows the age of the user from its user-profile, it calculates the BMI value and records the same in its database. Now as the user completes the nature's call, the toilet has already collected a sample of its user’s body waste and has started the tests that can be performed on that particular sample.

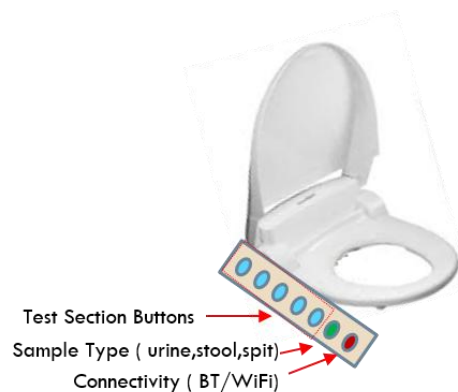
The following is a non-exhaustive list of tests that can be performed by the toilet on the user’s sample:

1. Urine:
  - a. Kidney stone
  - b. Sugar level
  - c. Urinary tract infection
  - d. Pregnancy
2. Stool:
  - a. Fecal occult blood
  - b. Fecal pH / Acidity test
3. Spit:
  - a. Alcohol presence

## II. FEASIBILITY STUDY

### 1.1. Smart toilet bidet design

To discuss the design feasibility of toilet bidet here we want to present very basic architecture design & working.



**Figure 3. bidet design**

To complement the purpose of collecting the sample, smart toilet can take use of existing technology like vacuum toilet which uses suction power to remove urine and feces. In our case, we can use vacuum toilet to flush the sample and collect in an apparatus. This will ensure no water is used before the sample reaches the sample collecting apparatus. Toilet bidet has side control buttons. First of all user has to select the sample type using the first sample selecting toggle button. Based on the sample type selected, relevant testing buttons will get activated. For example, if user selects sample type as urine then below test option will be activated:

1. Kidney stone
2. Sugar level
3. Urinary tract infection
4. Pregnancy

Using the connectivity button user can turn-on/off the smart toilet connectivity to cloud server. To automatically maintain user session fingerprint sensor can be provided on bidet panel or door. So that user automatically logs-

in/out from the system. Toilet bidet design can be modified & scaled as per testing requirement & technology enhancement.

### 1.2. Smart testing process

As shown in figure, initially it's assumed that test tubes are washed and filled with required quantity of chemical for testing. Now when testing is triggered by selecting the testing sample from button on side of bidet, sample is collected in sample apparatus pot. Automatic system will take sample from Sample apparatus & fill the required quantity of sample in the test tubes. Testing cycle will start and on completion, based on changed color, test results will be calculated and shared to end user via cloud server. After performing these tests, the toilet will be automatically flushed.

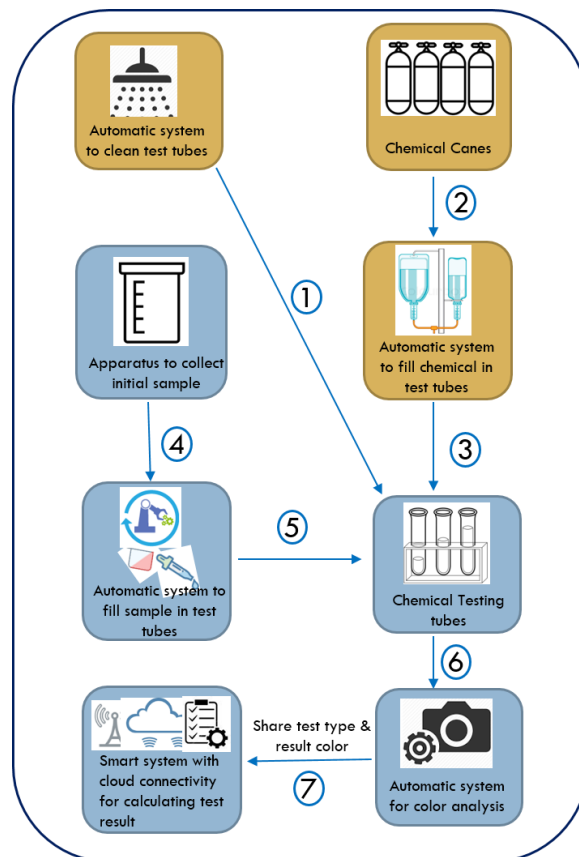


Figure 4. smart testing process design

The user can then analyze this information on his personal computer or smartphone which will also enable him to see the trend in his test report's data. User may choose to share the test results with other users like family members or can share it directly to his doctor.

### 1.3. Testing feasibility

Here we will discuss some basic approach & methods to cover feasibility of some tests in smart toilet.

- a) Sugar Test: -Sugar level can be measured from urine by chemical test, for example Benedict's reagent can be used to measure sugar level from green, yellow, or brick red precipitates formed.
  - b) Kidney Test: -Kidney diseases can be detected by the presence of Creatinine, Specific gravity and Protein in the urine. Strips are available which can test Kidney function and based upon the color change kidney functioning can be diagnosed.
  - c) Pregnancy Test: -Pregnancy can be easily confirmed with chemical test on urine sample which change color if beta subunit of human chorionic gonadotropin (hCG) is present in the urine
  - d) Urinary tract infection Test: -Leukocyte esterase presence can be detected by chemical test. Positive test confirm the white cells in the urine which indicates a urinary tract infection.
  - e) Fecal occult blood Test: -Blood presence can be detected by change in color with Hydrogen peroxide. From this test blood loss in the gastrointestinal tract, anywhere from the mouth to the colon can be detected.
  - f) Fecal pH / Acidity test: - Acidity can be diagnose by testing fecal sample with Nitrazine chemical and comparing against a color scale.
  - g) Alcohol presence Test: -Alcohol presence can be easily detected by change in color with chemicals, Tetramethylbenzidine (TMB) 0.12mg, Alcohol Oxidase 0.5 IU, Peroxidase 0.35 IU and Proteins 0.15mg.
- Further in future with the enhancement of medical science & technology, it would be easy to cover more diagnosis test using smart toilet.

### **III. RELATED WORKS**

All the works done till now focus on one or the other aspects of this field. Toto Japanese Company) has developed "Intelligence Toilet II" which is capable of basic functions like body temperature, blood pressure, sugar levels, etc. But it is majorly used in Japan and exported to few countries like USA and China.

### **IV. CONCLUSION**

As the saying goes - prevention is better than cure. By making use of the smart toilet, a user can get to know about a lots of medical conditions without even visiting a doctor or a lab. This will give user the preliminary diagnosis of a disease so that necessary actions or steps can be taken, more importantly at correct time, giving users better opportunities to deal with that particular condition.

### **REFERENCES**

- [1] <https://www.lalpathlabs.com>
- [2] [www.npss.org](http://www.npss.org)
- [3] <http://www.toto.com/>
- [4] <https://en.wikipedia.org>
- [5] <https://www.ncbi.nlm.nih.gov/>
- [6] <http://craigmedical.com>